

MAXIM

High-Speed, Single-Supply, Quad, SPST Analog Switches

General Description

The MAX4591/MAX4592/MAX4593 are high-speed, precision, quad, single-pole/single-throw (SPST) analog switches designed to operate at +12V or +15V. The MAX4591 has four normally closed (NC) switches, and the MAX4592 has four normally open (NO) switches. The MAX4593 has two NO and two NC switches. All three devices offer low leakage (100pA max) and fast switching speeds ($t_{ON} \leq 80\text{ns}$, $t_{OFF} \leq 45\text{ns}$).

With a +12V supply, the MAX4591/MAX4592/MAX4593 offer guaranteed 1 Ω max channel-to-channel matching, 20 Ω max on-resistance (R_{ON}), and 1.75 Ω max R_{ON} flatness over the specified range.

These switches are also fully specified for single +15V operation, with 16 Ω max R_{ON} , 1.5 Ω max R_{ON} match, and 1.5 Ω max flatness. For low-voltage or dual-supply operation, refer to the MAX391 data sheet.

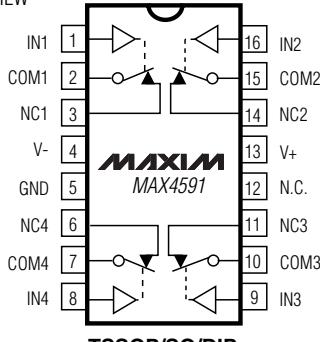
These low-voltage switches also offer 5pC max charge injection, and electrostatic discharge (ESD) protection is greater than 2000V, per Method 3015.7.

Applications

Test Equipment	Sample-and-Hold Circuits
Disk Drives	Guidance and Control Systems
Tape Drives	Military Radios
Audio and Video	Communications Systems
Switching	PBX, PABX
Heads-Up Displays	

Pin Configurations/Functional Diagrams/Truth Tables

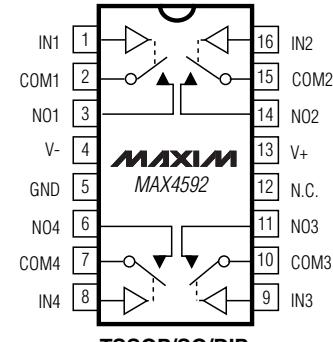
TOP VIEW



TSSOP/SO/DIP

MAX4591	
LOGIC	SWITCH
0	ON
1	OFF

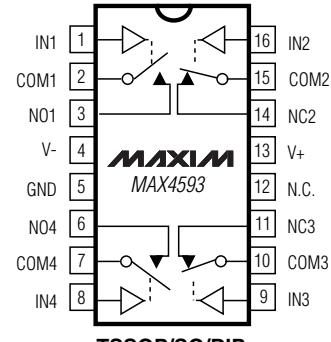
N.C. = NO CONNECTION



TSSOP/SO/DIP

MAX4592	
LOGIC	SWITCH
0	OFF
1	ON

SWITCHES SHOWN FOR LOGIC "0" INPUT



TSSOP/SO/DIP

LOGIC	SWITCHES 1, 4	SWITCHES 2, 3
0	OFF	ON
1	ON	OFF

MAXIM

Maxim Integrated Products 1

For free samples and the latest literature, visit www.maxim-ic.com or phone 1-800-998-8800.
For small orders, phone 1-800-835-8769.

MAX4591/MAX4592/MAX4593

High-Speed, Single-Supply, Quad, SPST Analog Switches

ABSOLUTE MAXIMUM RATINGS

V+ to GND	-0.3V to +17V
V _{IN} -, V _{COM} -, V _{NC} -, V _{NO} _- (Note 1)	V- to V+
Current (any terminal)	30mA
Peak Current, COM-, NO-, NC-	
(pulsed at 1ms, 10% duty cycle max)	100mA
ESD per Method 3015.7	>2000V
Continuous Power Dissipation (T _A = +70°C)	
16-Pin TSSOP (derate 5.70mW/°C above +70°C)	457mW

16-Pin Narrow SO (derate 8.70mW/°C above +70°C)	696mW
16-Pin Plastic DIP (derate 10.53mW/°C above +70°C)	842mW
Operating Temperature Ranges	
MAX459_C_E	0°C to +70°C
MAX459_E_E	-40°C to +85°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (soldering, 10s)	+300°C

Note 1: Signals on NC-, NO-, COM-, or IN- exceeding V+ or V- are clamped by internal diodes. Limit forward diode current to maximum current rating.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS—Single +12V Supply

(V+ = +12V, V- = GND = 0, V_{INH} = 5V, V_{INL} = 0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
ANALOG SWITCH						
Analog Signal Range	V _{COM} -, V _{NO} -, V _{NC} _-	(Note 3)	C, E	V-	V+	V
On-Resistance	R _{ON}	I _{COM} _ = -10mA, V _{NO} _ or V _{NC} _ = 10V	T _A = +25°C	16	20	Ω
			C, E		24	
On-Resistance Match Between Channels (Note 4)	ΔR _{ON}	I _{COM} _ = -10mA, V _{NO} _ or V _{NC} _ = 10V	T _A = +25°C	0.5	1	Ω
			C, E		1.5	
On-Resistance Flatness (Note 5)	R _{FLAT(ON)}	I _{COM} _ = -10mA; V _{NO} _ or V _{NC} _ = 3V, 6V, 9V	T _A = +25°C	1	1.75	Ω
			C, E		2	
NO or NC Off-Leakage Current (Note 6)	I _{NO(OFF)} or I _{NC(OFF)}	V+ = 15.5V; V _{COM} _ = 14V, 1V; V _{NO} _ or V _{NC} _ = 1V, 14V	T _A = +25°C	-0.1	0.01	nA
			C, E	-5	5	
COM Off-Leakage Current (Note 6)	I _{COM(OFF)}	V+ = 15.5V; V _{COM} _ = 14V, 1V; V _{NO} _ or V _{NC} _ = 1V, 14V	T _A = +25°C	-0.1	0.01	nA
			C, E	-5	5	
COM On-Leakage Current (Note 6)	I _{COM(ON)}	V+ = 15.5V; V _{COM} _ = 14V, 1V; V _{NO} _ or V _{NC} _ = 14V, 1V, or floating	T _A = +25°C	-0.2	0.01	nA
			C, E	-10	10	

High-Speed, Single-Supply, Quad, SPST Analog Switches

ELECTRICAL CHARACTERISTICS—Single +12V Supply (continued)

($V_+ = +12V$, $V_- = GND = 0$, $V_{INH} = 5V$, $V_{INL} = 0.8V$, $T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $T_A = +25^\circ C$.)
(Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
LOGIC INPUT							
Input Current with Input Voltage High	I_{INH}	$IN_- = V_+$, all others = 0.8V		-0.5	0.005	0.5	μA
Input Current with Input Voltage Low	I_{INL}	$IN_- = 0.8V$, all others = V_+		-0.5	0.005	0.5	μA
DYNAMIC							
Turn-On Time	t_{ON}	$V_{COM_} = 10V$, Figure 2	$T_A = +25^\circ C$	50		80	ns
			C, E	90			
Turn-Off Time	t_{OFF}	$V_{COM_} = 10V$, Figure 2	$T_A = +25^\circ C$	30		45	ns
			C, E	50			
Break-Before-Make Time Delay (Note 3)	t_D	MAX4593 only, $R_L = 300\Omega$, $C_L = 35pF$, Figure 3		5	20		ns
Charge Injection (Note 3)	Q	$C_L = 1nF$, $V_{GEN} = 0$, $R_{GEN} = 0\Omega$, Figure 4	$T_A = +25^\circ C$	2		5	pC
Off-Isolation (Note 7)	OIRR	$R_L = 50\Omega$, $C_L = 5pF$, $f = 10MHz$, Figure 5	$T_A = +25^\circ C$	72			dB
Crosstalk (Note 8)		$R_L = 50\Omega$, $C_L = 5pF$, $f = 10MHz$, Figure 6	$T_A = +25^\circ C$	85			dB
NC_ or NO_ Capacitance	$C_{(OFF)}$	$f = 1MHz$, Figure 7	$T_A = +25^\circ C$	9			pF
COM_ Off-Capacitance	C_{COM_OFF}	$f = 1MHz$, Figure 7	$T_A = +25^\circ C$	9			pF
COM_ On-Capacitance	C_{COM_ON}	$f = 1MHz$, Figure 8	$T_A = +25^\circ C$	22			pF
SUPPLY							
Power-Supply Range				3	16		V
Positive Supply Current	I_+	$V_+ = 15V$, $V_{IN_} = 0$ or V_+ , all channels on or off	C, E	-1	0.001	1	μA

High-Speed, Single-Supply, Quad, SPST Analog Switches

ELECTRICAL CHARACTERISTICS—Single +15V Supply

($V_+ = +15V$, $V_- = GND = 0$, $V_{INH} = 5V$, $V_{INL} = 0.8V$, $T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $T_A = +25^\circ C$.)
(Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Analog Signal Range	$V_{COM_}$, $V_{NO_}$, $V_{NC_}$	(Note 3)		0		V_+	V
On-Resistance	R_{ON}	$I_{COM_} = -10mA$, $V_{NO_}$ or $V_{NC_} = 10V$	$T_A = +25^\circ C$	12	16		Ω
		C, E				2.0	
On-Resistance Match Between Channels (Notes 3, 4)	ΔR_{ON}	$I_{COM_} = -10mA$, $V_{NO_}$ or $V_{NC_} = 10V$	$T_A = +25^\circ C$	0.5	1.5		Ω
		C, E				2.0	
On-Resistance Flatness (Notes 3, 5)	$R_{FLAT(ON)}$	$I_{COM_} = -10mA$; $V_{NO_}$ or $V_{NC_} = 3V, 6V, 9V$	$T_A = +25^\circ C$	0.7	1.5		Ω
		C, E				2.0	
NO_ or NC_ Off-Leakage Current (Note 6)	I_{NO_OFF} or I_{NC_OFF}	$V_+ = 15.5V$; $V_{COM_} = 14V, 1V$; $V_{NO_}$ or $V_{NC_} = 1V, 14V$	$T_A = +25^\circ C$	-0.1	0.01	0.1	nA
		C, E		-5		5	
COM_ Off-Leakage Current (Note 6)	I_{COM_OFF}	$V_+ = 15.5V$; $V_{COM_} = 14V, 1V$; $V_{NO_}$ or $V_{NC_} = 1V, 14V$	$T_A = +25^\circ C$	-0.1	0.01	0.1	nA
		C, E		-5		5	
COM_ On-Leakage Current (Note 6)	I_{COM_ON}	$V_+ = 15.5V$; $V_{COM_} = 14V, 1V$; $V_{NO_}$ or $V_{NC_} = 14V, 1V$, or floating	$T_A = +25^\circ C$	-0.2	0.02	0.2	nA
		C, E		-10		10	
DYNAMIC							
Turn-On Time	t_{ON}	$V_{NO_}$ or $V_{NC_} = 10V$, Figure 2	$T_A = +25^\circ C$	60	80		ns
		C, E				90	
Turn-Off Time	t_{OFF}	$V_{NO_}$ or $V_{NC_} = 10V$, Figure 2	$T_A = +25^\circ C$	30	40		ns
		C, E				50	
Break-Before-Make Time Delay (Note 3)	t_D	MAX4593 only, $R_L = 300\Omega$, $C_L = 35pF$		5	20		ns
Charge Injection (Note 3)	Q	$C_L = 1nF$, $V_{GEN} = 0$, $R_{GEN} = 0\Omega$, Figure 4	$T_A = +25^\circ C$	2	5		pC
SUPPLY							
Positive Supply Current	I_+	$V_+ = 15V$, $V_{IN_} = 0$ or V_+ , all channels on or off		-1	0.001	1	μA
Negative Supply Current	I_-	$V_+ = 15V$, $V_{IN_} = 0$ or V_+ , all channels on or off		-1	0.001	1	μA

Note 2: The algebraic convention, where the most negative value is a minimum and the most positive value a maximum, is used in this data sheet.

Note 3: Guaranteed by design.

Note 4: $\Delta R_{ON} = \Delta R_{ON} \text{ max} - \Delta R_{ON} \text{ min}$.

Note 5: Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal range.

Note 6: Leakage parameters are 100% tested at maximum rated hot temperature and guaranteed by correlation at $+25^\circ C$.

Note 7: Off-isolation = $20\log_{10} [V_{COM} / (V_{NC} \text{ or } V_{NO})]$, V_{COM} = output, V_{NC} or V_{NO} = input to off switch.

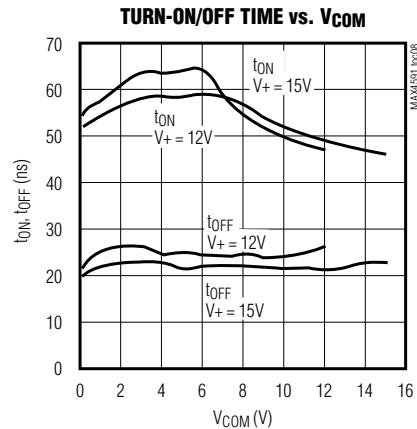
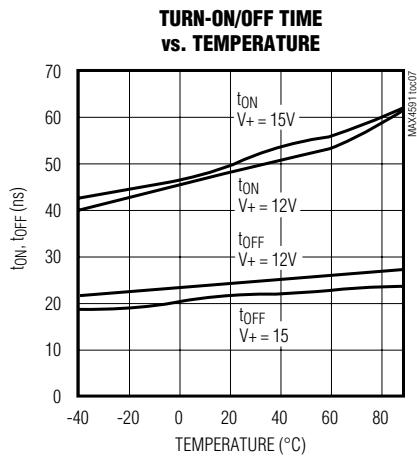
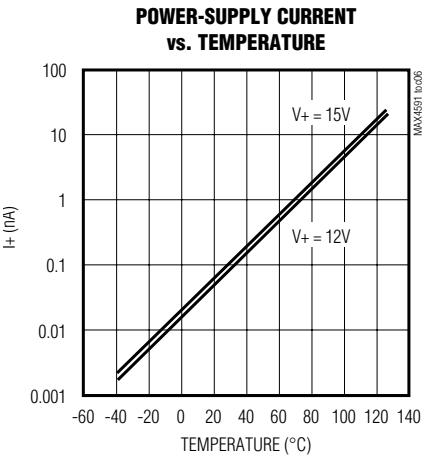
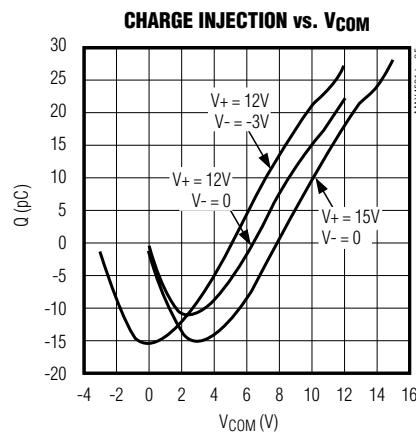
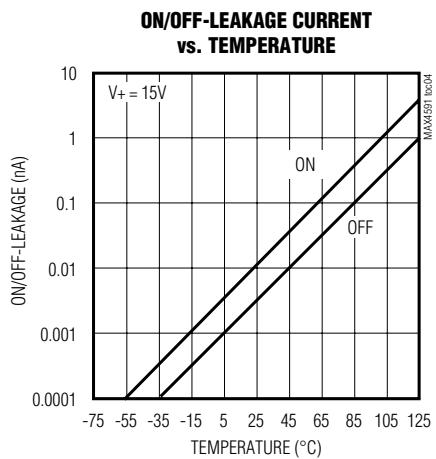
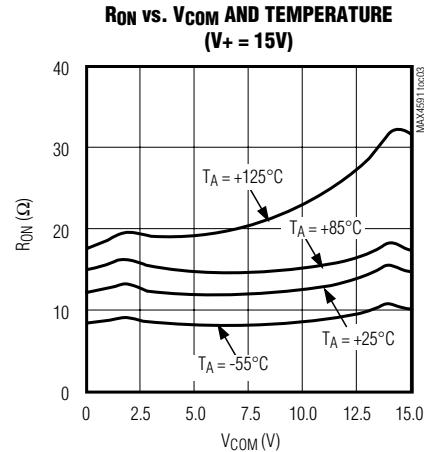
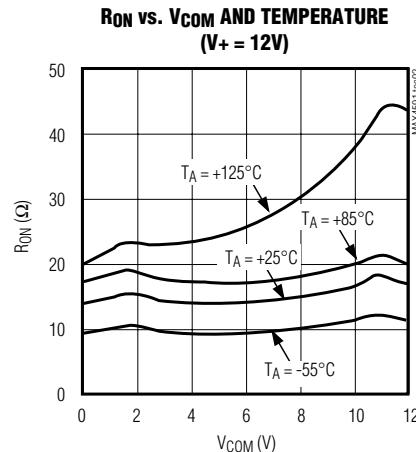
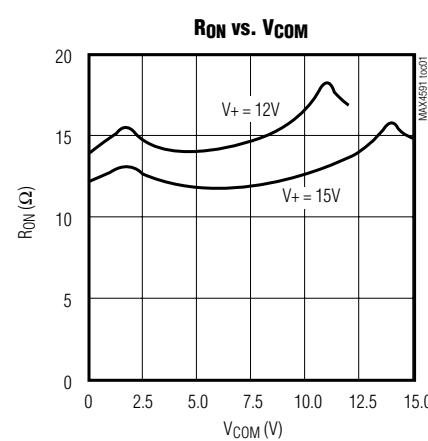
Note 8: Between any two switches.

High-Speed, Single-Supply, Quad, SPST Analog Switches

Typical Operating Characteristics

($V_- = GND = 0$, $IN_- = 0$ or V_+ , $T_A = +25^\circ C$, unless otherwise noted.)

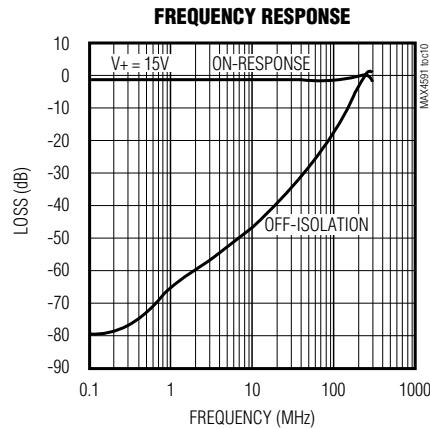
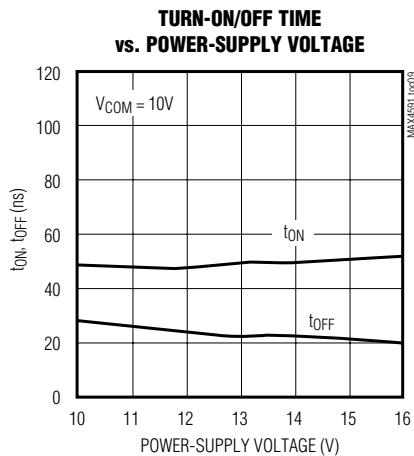
MAX4591/MAX4592/MAX4593



High-Speed, Single-Supply, Quad, SPST Analog Switches

Typical Operating Characteristics (continued)

(V₋ = GND = 0, IN₋ = 0 or V₊, T_A = +25°C, unless otherwise noted.)



Pin Description

PIN	NAME	FUNCTION
1, 16, 9, 8	IN1-IN4	Switch Input Terminals. Drive $\leq 0.8V$ for logic "0"; drive $\geq 5V$ for logic "1".
2, 15, 10, 7	COM1-COM4	Analog Switch Common Terminal
3, 14, 11, 6	NO1-NO4 or NC1-NC4	Switch Inputs
4	V-	Negative Supply Voltage Input. Normally connected to ground.
5	GND	Ground
12	N.C.	No Connection. Not internally connected.
13	V+	Positive Supply Voltage Input. Connected to substrate.

Applications Information

Overvoltage Protection

Proper power-supply sequencing is recommended for all CMOS devices. Do not exceed the absolute maximum ratings because stresses beyond the listed ratings may cause permanent damage to the devices. Always sequence V₊ on first, followed by the logic inputs. If power-supply sequencing is not possible, add a small signal diode in series with V₊ for overvoltage protection (Figure 1). Adding a diode reduces the analog signal range to 1V below V₊, but low switch resistance and low leakage characteristics are unaffected. Device operation is unchanged, and the difference between V₊ and V₋ should not exceed 17V.

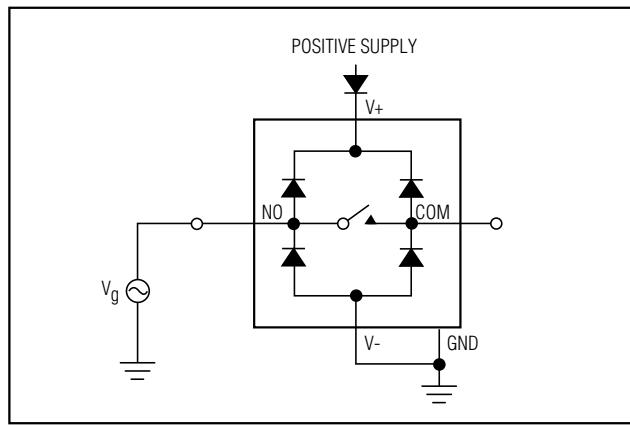


Figure 1. Overvoltage Protection Using Two External Blocking Diodes

High-Speed, Single-Supply, Quad, SPST Analog Switches

Test Circuits/Timing Diagrams

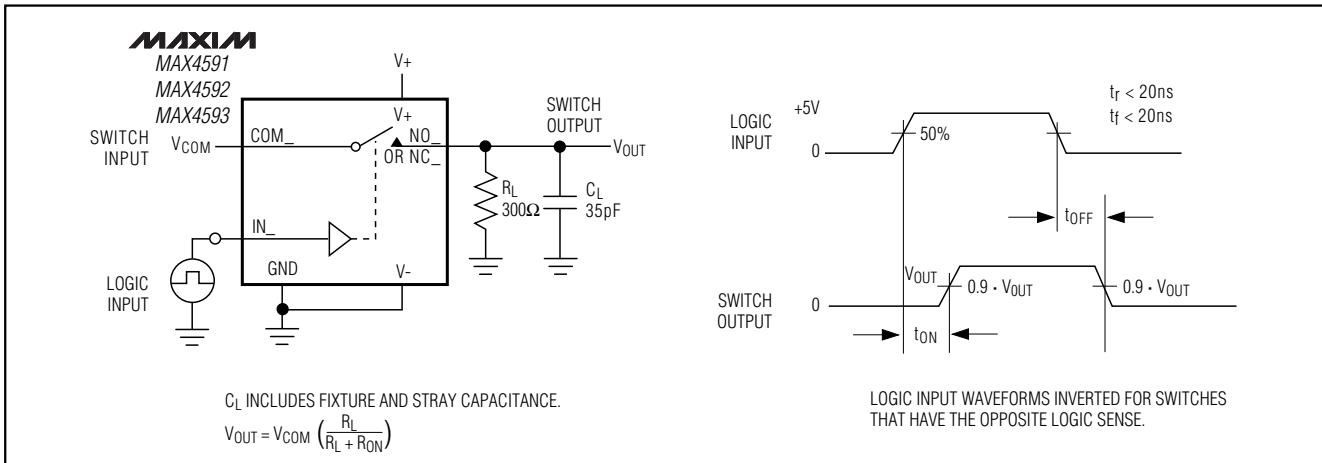


Figure 2. Switching Time

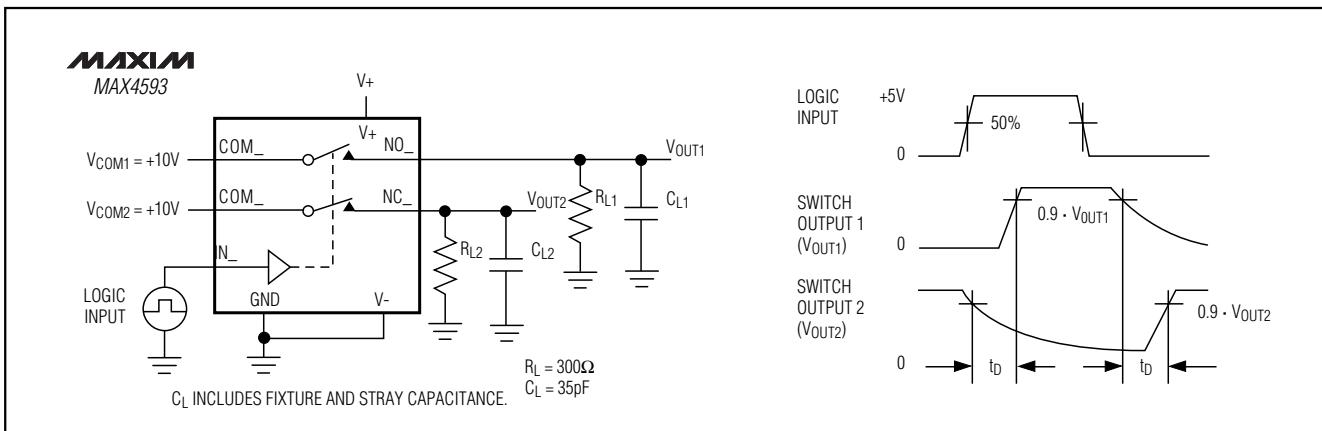


Figure 3. Break-Before-Make Interval (MAX4593 Only)

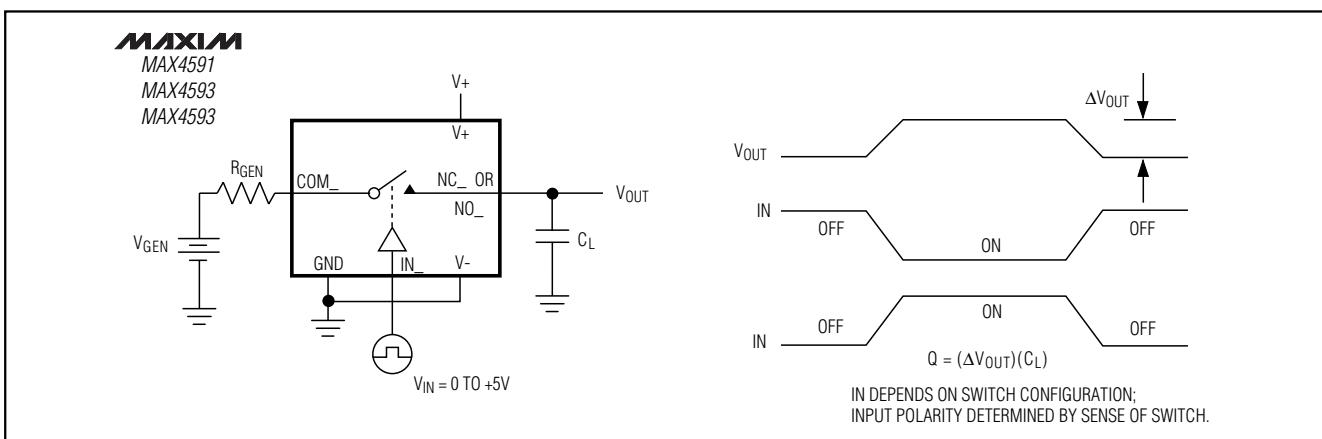


Figure 4. Charge Injection

High-Speed, Single-Supply, Quad, SPST Analog Switches

Test Circuits/Timing Diagrams (continued)

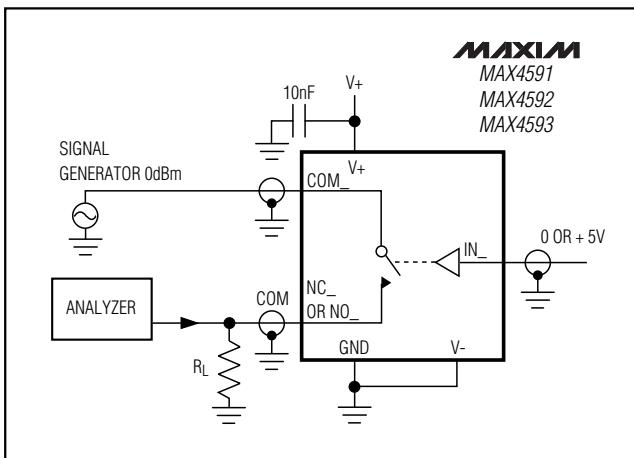


Figure 5. Off-Isolation

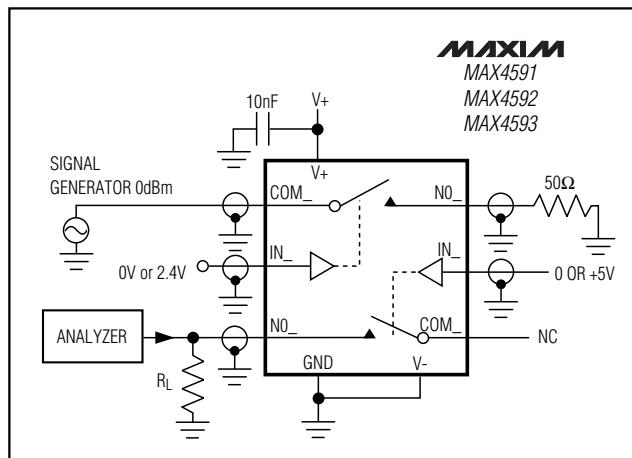


Figure 6. Crosstalk

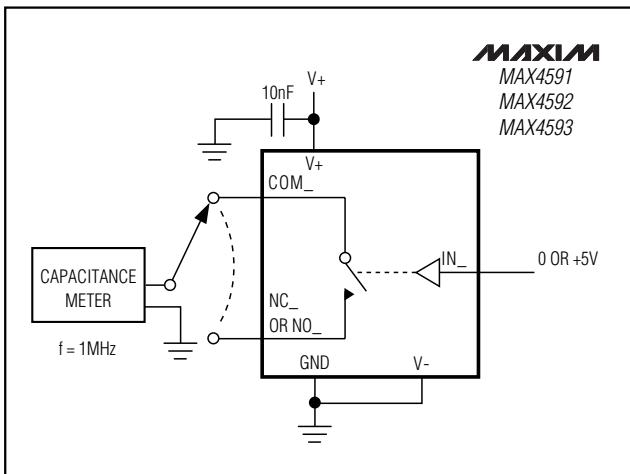


Figure 7. Channel Off-Capacitance

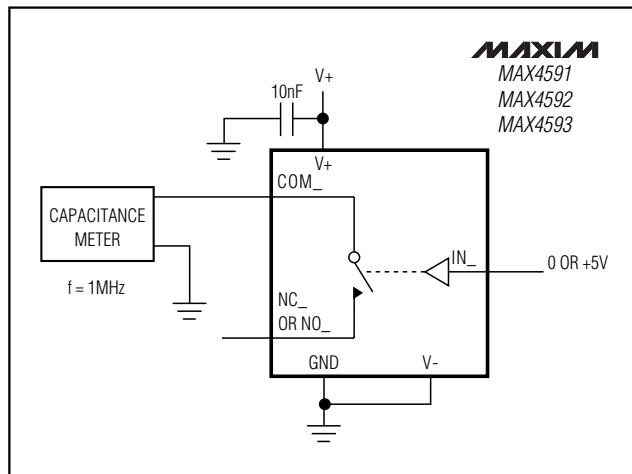


Figure 8. Channel On-Capacitance

High-Speed, Single-Supply, Quad, SPST Analog Switches

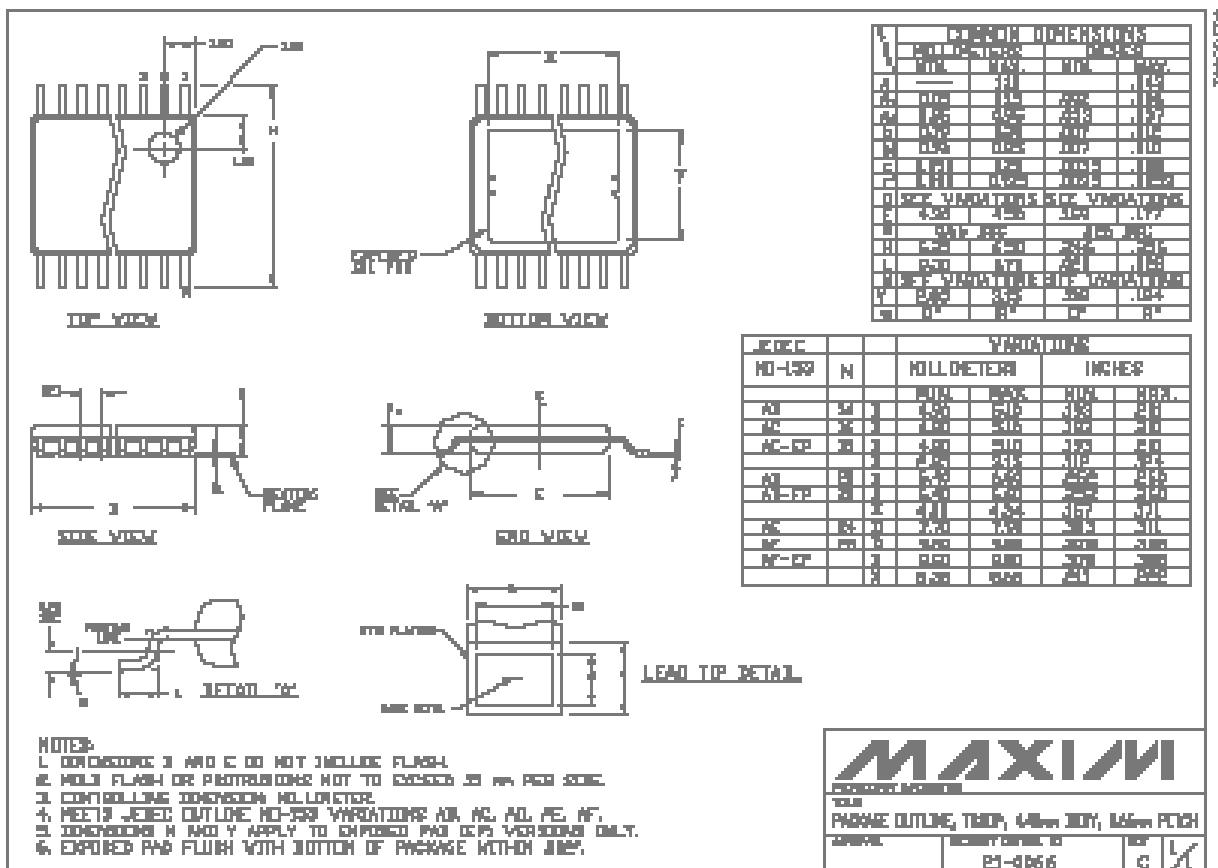
Ordering Information (continued)

PART	TEMP. RANGE	PIN-PACKAGE
MAX4592CUE	0°C to +70°C	16 TSSOP
MAX4592CSE	0°C to +70°C	16 Narrow SO
MAX4592CPE	0°C to +70°C	16 Plastic DIP
MAX4592EUE	-40°C to +85°C	16 TSSOP
MAX4592ESE	-40°C to +85°C	16 Narrow SO
MAX4592EPE	-40°C to +85°C	16 Plastic DIP
MAX4593CUE	0°C to +70°C	16 TSSOP
MAX4593CSE	0°C to +70°C	16 Narrow SO
MAX4593CPE	0°C to +70°C	16 Plastic DIP
MAX4593EUE	-40°C to +85°C	16 TSSOP
MAX4593ESE	-40°C to +85°C	16 Narrow SO
MAX4593EPE	-40°C to +85°C	16 Plastic DIP

Chip Information

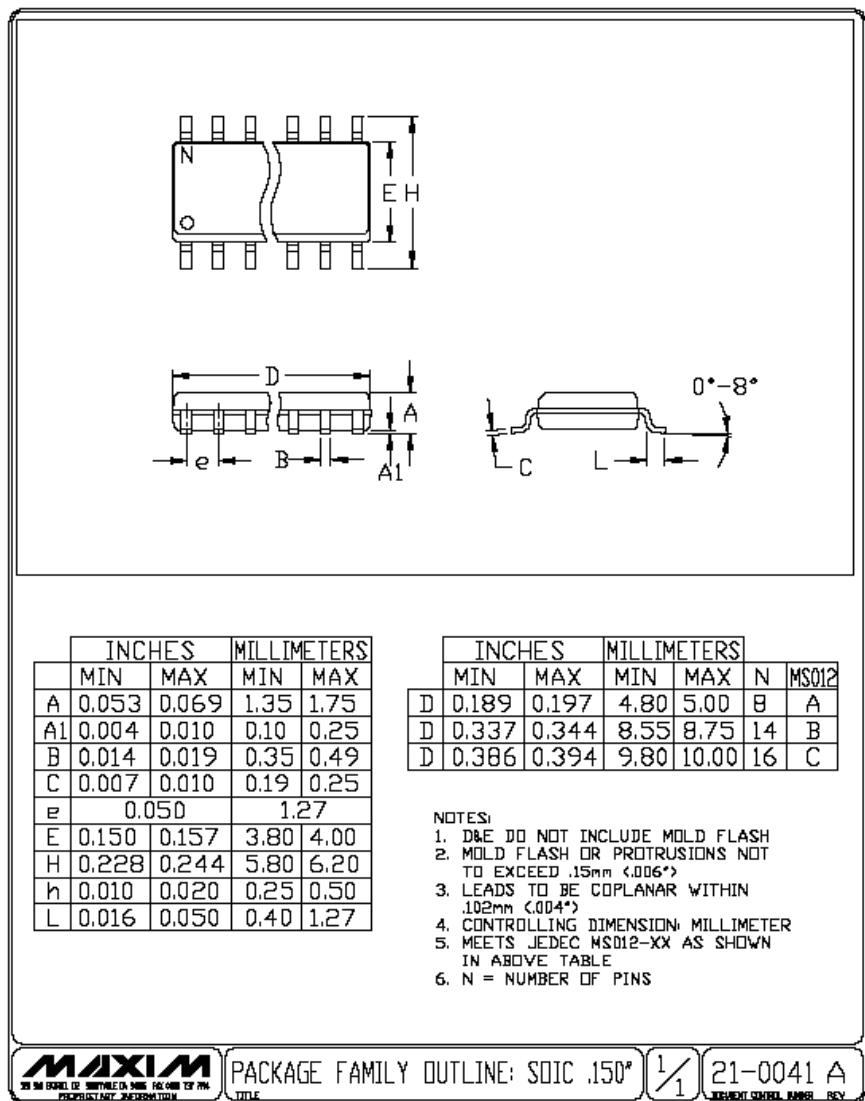
TRANSISTOR COUNT: 76

Package Information



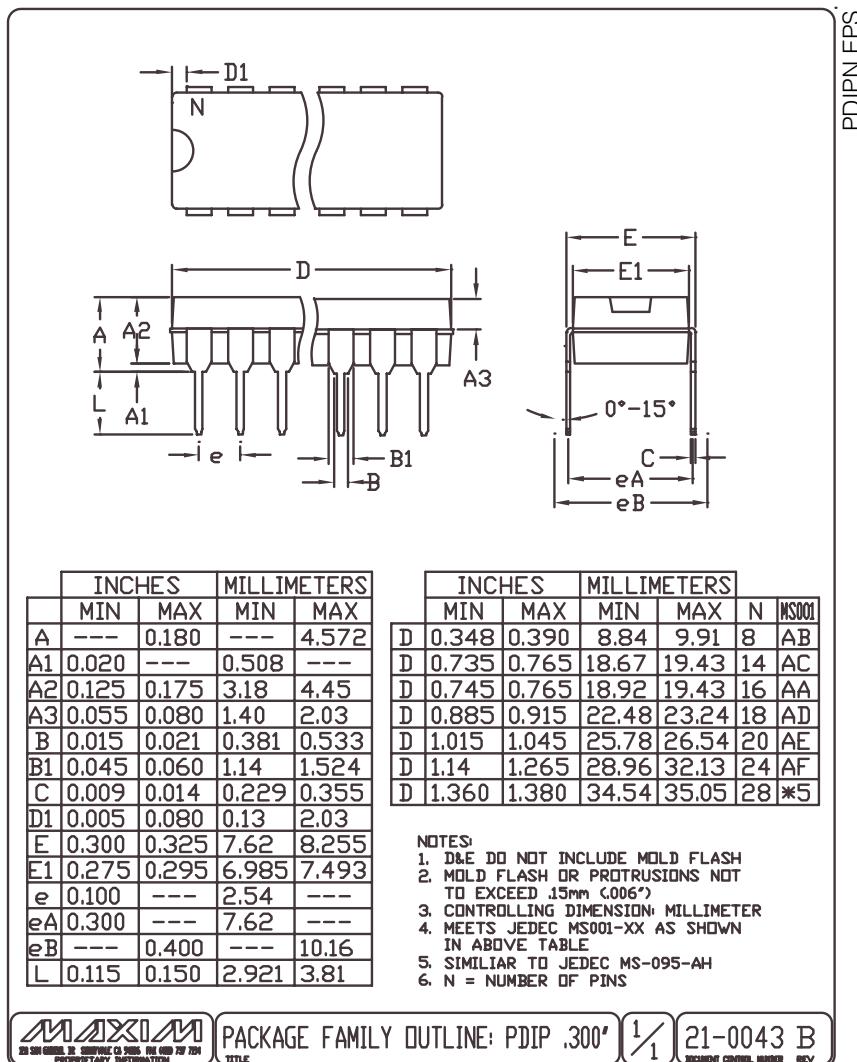
High-Speed, Single-Supply, Quad, SPST Analog Switches

Package Information (continued)



High-Speed, Single-Supply, Quad, SPST Analog Switches

Package Information (continued)



High-Speed, Single-Supply, Quad, SPST Analog Switches

NOTES

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

12 **Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600**